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WM. A. TAYLOR, Chief, and the Office of Markets
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CHARACTERISTICS AND QUALITY OF MONTANA-GROWN WHEAT.[1]

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INTRODUCTION.

Wheat production in Montana has shown a great increase during the past five or six years, due to rapid settlement, and a constantly increasing volume of wheat from this State is finding its way to the eastern and likewise to the far western grain markets. Although a small quantity of this wheat has been received at the eastern markets for several years, yet among many millers and wheat buyers it still retains the status of a "newcomer," and its reputation as to milling quality is largely dependent upon hearsay. Undoubtedly, the comparatively

[1] The work covered by this bulletin was done under the direction of Dr. J. W. T. Duvel, in charge of the Office of Grain Standardization of the Bureau of Plant Industry. Since August 18, 1916, the grain-standardization work of the Department of Agriculture has been administered jointly by the Office of Markets and Rural Organization and the Bureau of Plant Industry in connection with the administration of the United States Grain Standards Act.

This investigation was initiated by Messrs. L. A. Fitz and C. H. Bailey, formerly of the Office of Grain Standardization. Mr. Oliver M. Holmes, of the Chamber of Commerce of Great Falls, Mont., and Mr. E. C. Russell, of Lewistown, Mont., assisted in securing suitable wheat samples, as did also Director F. B. Linfield and Messrs. Alfred Atkinson and J. B. Nelson, of the Montana Agricultural Experiment Station. The milling studies were carried on in cooperation with the North Dakota Agricultural Experiment Station, with the special assistance of Prof. E. F. Ladd and Messrs. W. L. Stockham and Thomas Sanderson.

NOTE.—This bulletin is intended for farmers in Montana and adjoining States and for grain buyers throughout the country.

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low prices that have been paid for wheat from this source in the past have been due largely to the lack of information as to its true character and quality as a milling wheat. This explanation is only reasonable in view of the fact that the demand for these wheats is constantly increasing as they become better known. The history of these wheats is but a repetition of that of any new raw material that appears upon the market. There is at first an apparent discrimination against it, largely because it has not yet established a reputation, and the manufacturer is loath to make use of it in any great quantity until its character and fitness for use have been ascertained. Under such conditions the demand for the product is weak and the price is relatively low. Several factors have tended to emphasize this condition as related to Montana wheats. One of these is the very wide range in character and quality that exists between the various types of wheat grown within the State. For example, the low-gluten, starchy, white wheats, such as the Club varieties, may be found growing in a field adjacent to one of Fife wheat reputed to have the combination of such qualities as make it supreme for the production of a bread flour. Aside from this, there is a wide range in climatic conditions within the borders of the State, and complications are further augmented by the introduction of irrigation. That the use of irrigation water causes deterioration in the milling of wheat, especially of those factors spoken of as "strength," which are so desirable in bread flours, is quite generally claimed by millers and is upheld by the investigations of the Utah Agricultural Experiment Station,[1] where it was found that irrigation caused a decrease in protein content, accompanied by a decrease in "baking strength;" and, further, the extent of the variation seems to be in a measure proportional to the amount of irrigation water used.

FUTURE OF WHEAT PRODUCTION IN MONTANA.

That Montana is to become one of the most important wheat-producing States is scarcely to be doubted when one considers the record of the past few years and the marvelous possibilities of this untried State. The 1910 census placed the wheat acreage in 1909 at 258,000, while the estimated acreage for 1912 was 803,000, an increase of 211 per cent in four years.[2] The crop of 1914 covered 910,000 acres. The total wheat production in 1912 was more than 19 million bushels, three times as great as the production in 1909, when it amounted to about 6 million bushels. Figure 1 is a map made up

[1] Stewart, Robert, and Hirst, C. T. The chemical milling and baking value of Utah wheats. Utah Agr. Exp. Sta. Bul. 125, p. 111–150. 1913.

Widtsoe, J. A., and Stewart, Robert. The chemical composition of crops as affected by different quantities of irrigation water. Utah Agr. Exp. Sta. Bul. 120, p. 201–240. 1912.

——— ——— The effect of irrigation on the growth and composition of plants at different periods of their development. Utah Agr. Exp. Sta. Bul. 119, p. 165–200. 1912.

[2] U. S. Department of Agriculture, Bureau of Statistics, Crop Reporter, v. 14, No. 12, sup., p. 99. 1912.

from the 1910 census reports, illustrating the distribution of the 1909 wheat crop in Montana. Figure 2 shows the sources of the samples secured for this investigation.

MARKETING CONDITIONS IN MONTANA.

The marketing and selling of wheat in Montana are surrounded by many seeming and real abuses. Wheat classification and grading are most confused on account of their variability. Wheat prices are based upon Minneapolis quotations, less the freight, the commission, and the margin that the local grain buyer considers necessary to cover the cost of handling and net himself a profit.

The fact that at many shipping points the volume of wheat is yet very small adds materially to the unit cost of handling, for the quan-

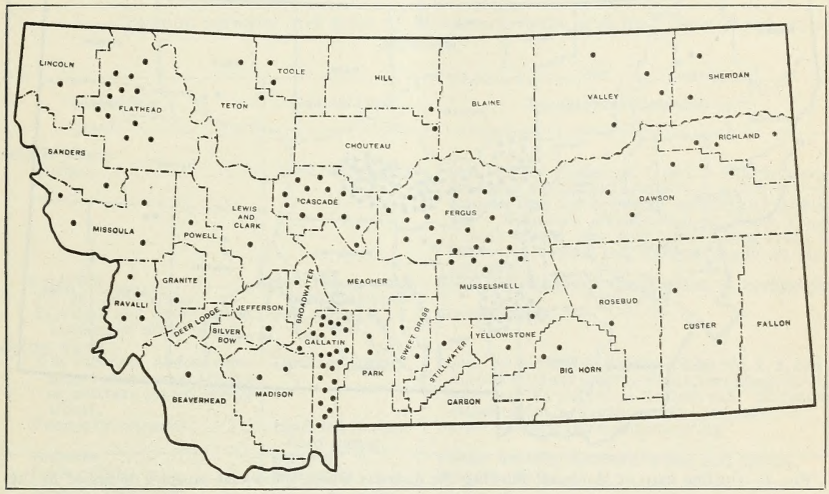


FIG. 1.—Outline map of Montana, showing the districts where wheat is produced. (From the 1910 census.) Each dot represents 50,000 bushels.

tity of grain received does not justify the building of elevators and warehousing facilities, and consequently the wheat must be handled by expensive man-power methods. At other points, where elevators have been built, the volume of grain is not sufficient to invite competition, or even in some cases to pay the expenses of the operation of the warehouse unless the grain is bought on a comparatively high margin.

The confusion that exists as to the classification of Montana wheat is largely dependent upon three factors, which may be summarized as follows:

(1) The fact that wheat of many varieties belonging to five distinct groups is grown within the borders of the State.

(2) The existence of several poorly defined systems of classification and grading.

(3) Varied environmental conditions within the State influencing the character of the grain, of which irrigation is probably the most important.

VARIETIES AND TYPES OF WHEAT GROWN IN MONTANA.

As has been said, the wheat grown in Montana may be divided into five distinct types and groups. The first and most important is the hard red winter wheat of the Turkey type. The estimates of the Bureau of Statistics for 1912 show that winter wheat constitutes about 60 per cent of the wheat grown in the State, and a very large proportion of this is undoubtedly of the type generally known as Turkey.

Hard spring wheat of the Fife or Bluestem groups is second in importance. The principal varieties are Red Fife and Bluestem.

Just what is the relative importance as to the quantity grown of the three remaining types would be difficult to ascertain. Some durum wheat is grown, probably the greater proportion in the eastern part

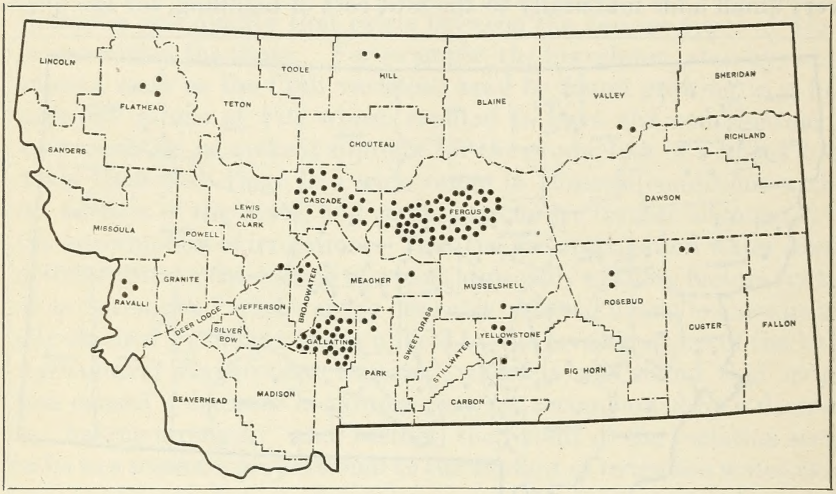


FIG. 2.—Outline map of Montana, showing the districts where the wheat samples discussed in this bulletin were obtained.

of the State, where the growing of winter wheat has not been demonstrated to be a success.

Soft wheats, both red and white, are grown in uncertain quantities, especially in the irrigated sections, such as the Gallatin Valley. The soft red wheat consists largely of the type known as Crail Fife. Other varieties, such as Velvet Chaff (winter), Galgalos, and Pringle Champlain, the latter of which seems to be of a semihard type, are grown to a very limited extent.

Varieties of white wheat, which are variously designated as Little Club, Fall Club, Spring Club, and Sonora, constitute the fifth class.

GRADING MONTANA WHEAT.

As has already been said, the grading of Montana wheats is very variable, and especially is this true at the primary markets. In certain localities an attempt is made to classify and grade the wheat

in accordance with the practices of the Minnesota State Grain Inspection Department. In others, a very different classification has been adopted, which system is fathered largely by elevator companies that have connections with Montana flour mills. Where sufficient grain is grown to invite competition in the grain-handling business, grading conditions are generally much better than where there is but one buyer. For instance, in several localities where there has been but one grain buyer, winter wheat, whether of poor or good quality, has been bought at uniform prices and no attempt made at grading, a practice that is manifestly unfair and offers encouragement to slipshod methods of harvesting and marketing grain. Table I gives in outline form a summary of these general commercial practices.

TABLE I.—*Common varieties and types of Montana wheats, with their commercial classification.*

Variety.	General type.	Commercial classification.
Winter wheat:		
Turkey	Hard red winter	Local, higher grades as 1 and 2 Turkey; lower grades as western red (grades 1, 2, and 3); starchy samples may not be graded better than 1 western red. Minnesota classification as No. 1, 2, and 3 hard winter; very poor quality wheat may be classed as western red; followed locally in some instances.
Crail Fife	Soft red or semi-hard red winter.	Local and Minnesota classification, as western red.
Velvet Chaff (winter)		
Fall Club and other winter varieties of white wheat.	Soft white	Western white.
Spring wheat:		
Fife, Bluestem, and all common varieties and strains of northern-grown spring wheat.	Hard red spring	Local, varies; higher quality grades No. 1, 2, and 3 northern; lower quality wheat, including starchy lots, may be classed as western red. Minnesota classification, as northern spring wheat.
Pringle Champlain	Hard red or semi-hard spring.	Varies; western and northern spring.
Galgalos	Soft red	Varies; western, northern spring, and durum.
Spring Club	Soft white	Western white.
Stanley, spring		
Other spring-sown white wheats.		
Arnautka	Hard, flinty	Durum; grades 1, 2, and 3 durum; local and terminal market classification probably identical.
Kubanka		
Pelissier, spring		
Other durum varieties		

The most uniform classification is followed with hard spring wheat. Generally the classification and division into the northern spring grades are much the same as those promulgated by the Minnesota State Grain Inspection Department. Good and fair quality of hard winter wheat is bought as No. 1 and No. 2 Turkey. Hard winter wheat, not thought to be good enough for these grades, is bought as western red wheat and graded No. 1, 2, or 3, according to quality. The western red grades afford a convenient place for such red wheats as for various reasons are not considered good enough for the northern spring or Turkey (hard winter) grades. This is also true for the soft red wheats, such as Crail Fife.

All white wheats are conveniently grouped as western white, in accordance with the general practice throughout the country. Durum wheat receives the usual separate classification.

WHEAT QUALITY.

Before proceeding with a discussion of the results of this investigation, some of the factors relating to milling quality will be considered. Accepting the proposition that the only sound basis for the determination of the quality of wheat is by a consideration of its fitness for the manufacture of flour and by a study of the characteristics of the flour, special emphasis has been laid upon investigations involving milling and baking tests.

The term "milling quality" has a varied meaning, and in speaking of wheat of high milling quality two millers may have very different standards in mind. Broadly speaking, any wheat which will yield a high percentage of white, sound flour is of good milling quality. But this definition holds only when wheat flour is considered as flour and it is not recognized that there is a remarkable variation in the characteristics of flour made from different types of wheat. The manufacturer of a cracker or pastry flour desires a wheat which is preferably low in protein, rather than glutinous, and he finds that the soft red or white wheats are well suited to his needs. In selecting he is chiefly concerned in securing wheat of these types that is plump and sound and that will yield a high percentage of white flour.

On the other hand, a miller who is making what is primarily a bread flour desires a hard glutinous wheat, the flour from which has a combination of qualities that under the proper treatment will produce a large light loaf of bread of even porosity or texture. Such flour is said to be of high baking strength. Because of the demand made by the baker for "strong" flour, the miller is often willing to sacrifice a little on flour yield to secure wheat the flour from which has this desirable characteristic. Another desired flour quality from the bakers' standpoint is water absorption, or the amount of water required by the flour to mix the dough to a standard consistency. Importance is attached to this, largely because of the relationship which is borne by this factor to yield of bread per unit of flour.

To recapitulate, from the standpoint of the miller, a high-grade milling wheat for bread making must yield a high percentage of white (color) merchantable (sound) flour of high baking strength (loaf volume and texture), which is capable of giving a good yield of bread per unit of flour by virtue of its ability to absorb water and retain the same (water absorption) during baking. Hard spring and hard winter wheats are best suited for the production of flour of this kind, but, on the other hand, flour from these types of wheat is not so well adapted for the making of crackers or pastry products.

It is possible that still another definition of a good milling wheat might be offered by a miller producing semolina for the manufacture of macaroni and other edible pastes. He desires a wheat which will produce a hard granular semolina containing a high percentage of gluten or gluten proteids, which are responsible for the peculiar qualities necessary in the manufacture of such products. He also desires a rich creamy or yellow product. Durum wheat offers a combination of qualities that make it especially desirable for such purposes.

COLOR OF FLOUR AND BREAD.

The importance attached to color of flour is dependent upon the natural demand of the consumer of white bread. The factors of color and flour yield bear a direct relationship to each other, the former being in a sense a limiting factor of the second. Were it not for the sacrifice of color, wheat could be ground much closer and the flour yield considerably increased without the flour suffering a marked deterioration of other qualities. In a study of the tables that follow, the color score of the bread and the flour yield or percentage of flour should be considered together.

WATER ABSORPTION.

The importance of the water absorption of a unit quantity of flour and its direct relationship to yield of bread have been discussed in the consideration of milling quality. It suffices to say that this factor is of considerable commercial importance. It is generally highest in the more glutinous flours and lowest in the soft, starchy types. In the following tables water absorption is expressed as the percentage of water used. A brief statement will explain the meaning of this term. In the baking tests 340 grams of flour are used in each loaf. If, in mixing, the equivalent of 170 grams of water were used, the absorption would be expressed as 50 per cent.

LOAF VOLUME AND TEXTURE.

In the baking tests which are reported herein, 340 grams of flour were used in each instance and the measured volume of the resultant loaf is expressed in cubic centimeters. Loaf volume, more than any other one factor, is considered indicative of strength in flour, but it should always be considered in connection with the texture score, which is based upon the size and number of air cells and the character of the cell walls.

HARD WINTER WHEAT.

As has been said, the wheat most extensively grown in Montana is hard winter wheat of the type known as Turkey. Although the production of spring wheat of the harder varieties has increased very rapidly during the past few years, the production of winter

wheat has more than kept pace with this increase. Because of its relatively greater importance, a far more complete study has been made of Turkey winter than of the other wheats.

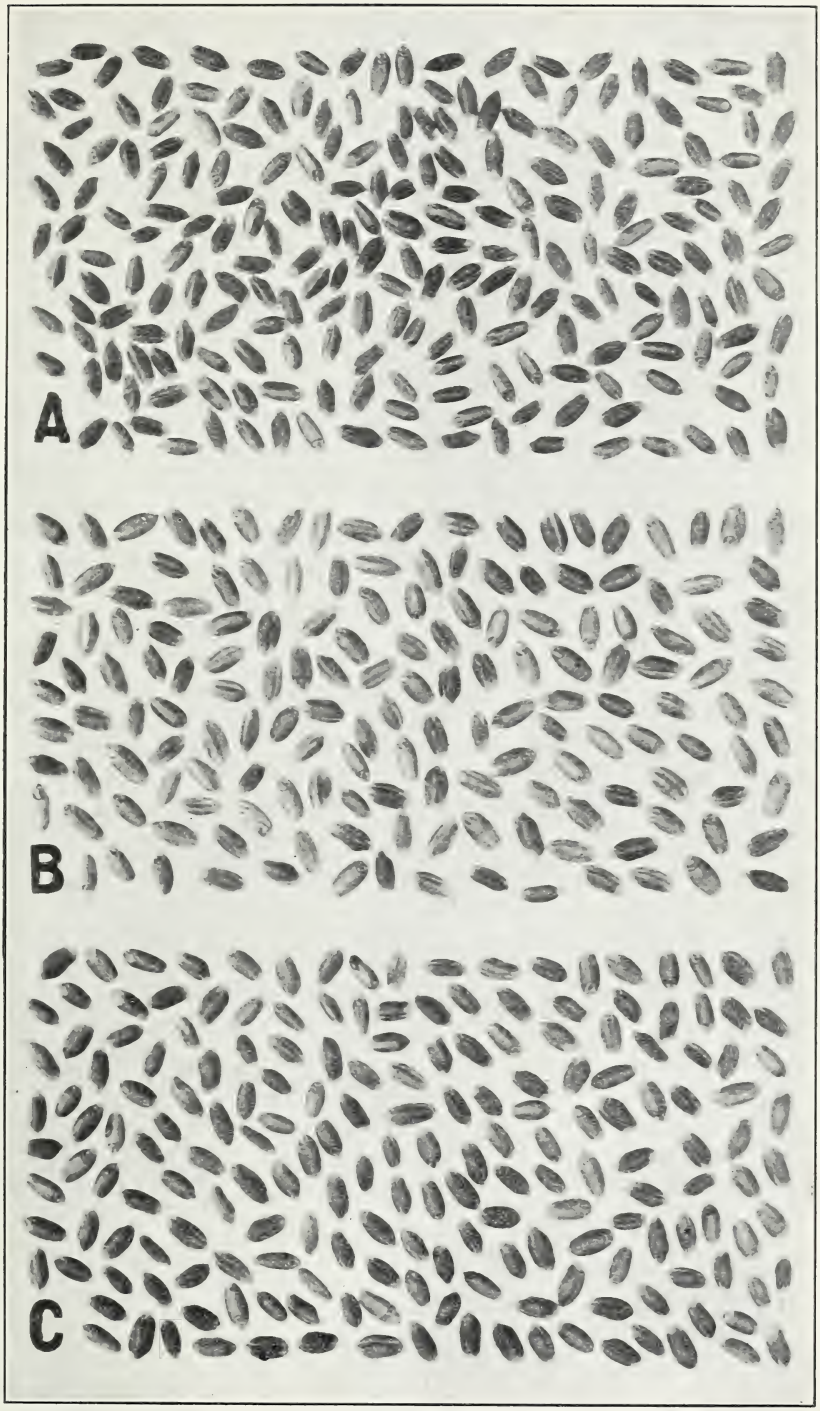
In shape of kernel and physical characters the Montana-grown Turkey wheat resembles that grown in Kansas, Nebraska, and other hard winter-wheat States, except in size of kernel. Usually the kernels are a little larger and quite often more plump. In this latter characteristic, however, there is as great a variation as in other sections. Plate I compares a typical sample of Montana-grown Turkey with two samples representing the usual variations of the Turkey wheat of the Central States.

The results of the milling, baking, and chemical studies with the samples of this variety or type are presented on the following pages in a series of tables and figures (Tables II and III and figures 3 to 13). Table II gives the results upon a limited number of samples of wheat of this type secured during the years 1908 and 1909, arranged according to the crop year, followed by a more comprehensive study that was made of the wheat of the three succeeding years.

It will be noted from this table that a very wide range in quality existed each year. The tests of the limited number of samples secured the first two years indicated that this wheat did not differ widely in quality from the hard winter wheats of other sections.

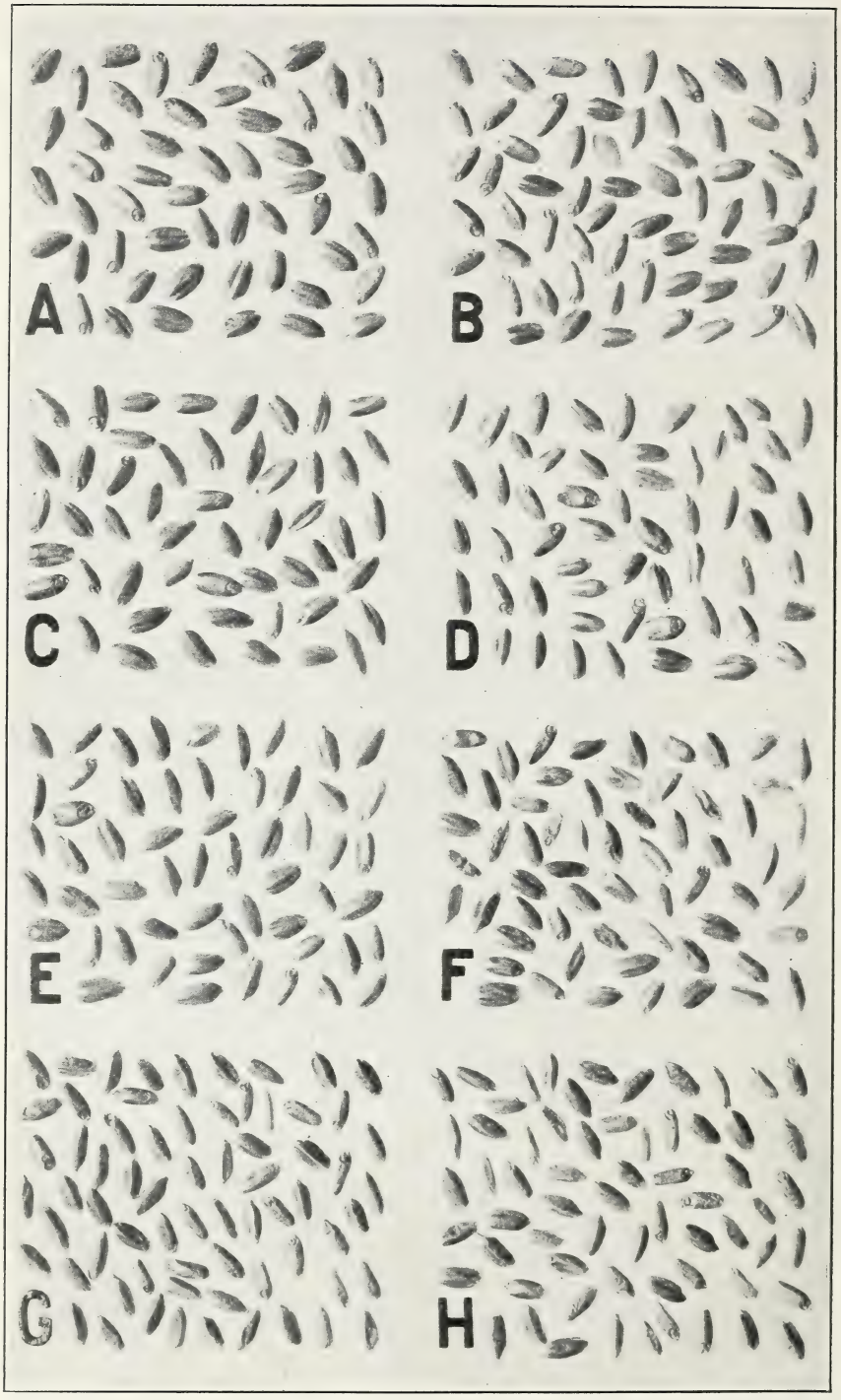
The tests for the three following years, 1910, 1911, and 1912, representing as they do a much larger number of samples, are far more interesting and suggestive. Certain striking variations were noted in the wheat of each crop year. That of 1910 was most uniform in quality. The samples secured were of about a uniform plumpness and were hard and glutinous. The results of the milling tests were likewise quite uniform. In absorption, the flour from the wheat of 1910 was lower than that of the two succeeding years; in the matter of strength, as indicated by loaf volume and texture, the flour was superior.

The wheat of the 1911 crop was not so uniform in quality as that of 1910. Many of the samples were more or less shrunken, and many were badly bleached and otherwise damaged in the field. Several samples, mostly from Fergus County, showed an abnormally high moisture content, due to rainy weather during harvest. These various factors are responsible for the much wider variation in milling results with the wheat of this year. Taken as a whole, the baking results with the flour did not differ greatly from the preceding year. The absorption was a little higher, and in strength there were no samples that ranked so high as those of the preceding year obtained from Yellowstone County. Two samples proved to be poorer than any that were obtained the previous year. The wheat of this year showed much greater range in crude protein. The variation, however, did not appear sectional and could probably be explained only by a study of local weather conditions.



COMPARISON OF MONTANA HARD WINTER (TURKEY) WHEAT WITH THAT OF OTHER SECTIONS, SHOWING THE LARGER AND MORE UNIFORM KERNELS OF THE MONTANA WHEAT.

A, Dark hard Turkey grown in Nebraska; *B*, typical Montana-grown Turkey; *C*, yellow-berry Turkey grown in Kansas.



ARRANGEMENT OF HARD WINTER WHEAT SAMPLES REFERRED TO IN TABLE III, CORRELATING PHYSICAL CHARACTERS AND MILLING QUALITY.

A and *B*, Plump or fairly plump, bright to slightly bleached; *C* and *D*, plump to a little shrunken, bleached, and a small percentage sprouted; *E* and *F*, plump to fairly thin, badly bleached, and a small percentage sprouted; *G* and *H*, badly bleached and sprouted or badly shrunken.

TABLE II.—*Baking tests of Montana hard winter (Turkey) wheat, showing sources of samples, milling quality, protein, and moisture content, for stated years.*

Sample No.	County in which grown.	Yield of straight flour.	Loss in milling.	Tests of straight flour.				Crude protein in flour, N×5.7.	Moisture in flour.	Crude protein in wheat, N×5.7.	Moisture in wheat.
				Color of bread.	Absorption of water.	Strength.					
						Volume of loaf.	Texture of flour.				
Crop of 1908:		*P. ct.*	*P. ct.*	*Score.*	*P. ct.*	*C. c.*	*Score.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
297 [a]	Cascade	71.6	4.4	98	58.8	2,270	.....	12.54	8.85	12.94	12.0
Crop of 1909:											
507	do	70.6	3.6	97	51.5	2,270	.....	11.34	10.32	11.80	12.0
508	Gallatin	69.4	4.1	99	51.2	2,350	.....	10.77	11.37	11.12	13.0
567 [b]		72.9	2.0	105	51.8	2,350	.....	12.37	10.58	13.40	13.0
Crop of 1910:											
733	Cascade	72.6	.9	99	54.4	2,110	96	13.40	9.69	14.71	10.3
734	do	72.0	.7	98	52.4	2,280	96	12.77	10.43	13.57	11.9
737	Fergus	73.0	1.3	97	56.5	2,250	98	12.37	9.61	13.74	10.2
738	do	72.2	2.4	96	53.8	2,130	98	11.57	9.27	11.34	12.0
739	do	72.8	.6	99	54.7	2,130	99	11.51	10.01	12.03	12.9
742	do	74.2	0	98	54.1	1,950	98	11.17	9.45	12.08	9.8
743	do	72.1	2.2	98	53.2	2,300	98	12.14	9.92	13.51	11.6
745	do	71.9	[c].1	99	54.7	2,380	99	11.97	10.11	11.80	12.1
747	do	72.8	.4	97	56.5	2,150	97	14.59	9.81	15.96	11.0
748	do	72.3	.1	99	54.7	2,250	.....	14.08	10.10	15.68	11.3
749	do	74.4	.4	98	56.5	2,100	.....	14.54	10.11	15.33	10.2
750	do	70.8	1.7	96	56.2	2,150	.....	14.54	10.84	15.16	12.0
756	do	72.9	[c]2.7	96	54.1	2,220	94	14.08	.....	15.68	12.8
726	Gallatin	73.4	0	99	52.6	1,900	96	9.41	9.86	10.26	10.8
730	do	72.0	1.3	96	52.4	2,230	96	9.98	10.38	11.17	10.5
722	Yellowstone	67.7	3.8	97	53.8	2,520	100	12.65	10.87	12.71	12.3
723	do	70.9	1.0	99	53.2	2,540	100	12.31	10.34	11.74	11.2
724	do	70.5	1.2	98	52.9	2,350	100	12.26	10.02	12.94	11.2
Average (1910).		72.1	.84	98	54.3	2,225	98	12.56	10.06	13.26	11.4
Crop of 1911:											
1071	Flathead	69.2	4.1	96	55.3	2,190	95	9.41	10.25	10.20	13.6
947	Cascade	72.8	1.1	98	60.0	2,100	94	9.98	10.05	10.15	11.5
1075	do	73.6	1.1	101	58.2	2,190	96	10.32	9.49	11.40	12.6
1076	do	69.4	3.1	99	57.6	2,170	95	10.66	9.68	11.57	13.0
1050	Fergus	70.9	1.8	98	59.7	2,340	94	12.48	10.89	13.68	14.3
1051	do	68.6	2.3	97	58.2	2,230	96	12.60	10.54	13.28	13.6
1052	do	64.4	4.6	101	58.2	2,380	97	12.77	.....	12.83	17.2
1053	do	70.3	2.6	98	58.2	2,100	93	11.63	10.66	12.71	14.0
1054	do	74.4	[c]1.4	100	58.5	2,080	96	13.85	9.87	14.82	11.9
1066	do	66.9	1.1	94	56.8	2,190	90	13.57	10.13	15.05	13.4
1078	do	68.3	1.1	95	55.0	2,100	96	13.22	10.43	15.28	13.4
1107	do	71.1	2.4	94	61.5	2,230	92	12.31	10.18	12.60	12.5
1108	do	69.0	2.8	101	59.7	2,250	94	11.63	10.73	12.31	13.6
1109	do	70.2	4.7	98	61.8	2,000	92	9.12	10.29	9.18	14.2
1110	do	71.9	1.6	98	58.8	2,070	94	11.69	10.47	11.51	14.6
1111	do	70.2	4.0	103	61.5	2,120	94	10.03	10.55	10.37	14.4
1112	do	70.1	2.2	103	59.1	2,210	95	10.83	10.93	11.97	15.4
1113	do	74.2	.7	102	60.6	2,040	94	10.89	9.69	11.69	12.0
1114	do	67.9	3.9	105	59.1	2,160	94	8.72	10.49	8.72	14.7
1115	do	71.2	.4	99	58.8	2,150	95	10.83	10.07	12.37	13.0
1116	do	71.2	2.3	99	61.2	2,270	95	10.83	10.61	11.17	14.0
1117	do	66.5	1.4	94	60.2	2,370	95	12.03	9.72	13.05	12.0
1118	do	73.4	[c]1.7	97	57.9	2,020	94	11.97	9.07	12.14	11.5
1119	do	73.2	.7	100	58.5	2,130	94	9.86	9.50	10.20	11.4
1062	Lewis-Clark	78.2	1.6	101	57.9	2,190	96	8.61	9.67	8.32	11.8
1056	Ravalli	78.4	[c]3.1	100	57.6	2,080	96	9.86	9.30	10.37	10.2
1046	Gallatin	72.2	1.1	101	57.9	2,030	96	10.72	10.19	11.00	12.2
1048	do	73.6	.2	98	57.9	1,890	94	9.23	9.95	9.92	11.1
1069	Park	74.6	1.6	94	58.2	1,880	92	9.12	10.01	9.12	13.9
1058	Meagher	72.1	1.8	98	58.5	2,040	93	10.77	10.13	11.74	14.0
1049	Custer	74.0	.3	98	56.5	2,140	94	10.83	9.41	11.17	11.2
Average (1911).		71.1	1.6	99	59.0	2,140	94	10.98	10.09	11.61	12.9

[a] Baking test with patent flour.
[b] Montana Turkey wheat secured at Chicago, Ill., where it was classed as Pacific coast red.
[c] Gain in milling.

TABLE II.—*Baking tests of Montana hard winter (Turkey) wheat, showing sources of samples, milling quality, protein, and moisture content for stated years*—Continued.

Sample No.	County in which grown.	Yield of straight flour.	Loss in milling.	Tests of straight flour.						Crude protein in wheat, N×5.7.	Moisture in wheat.
				Color of bread.	Absorption of water.	Strength.		Crude protein in flour, N×5.7.	Moisture in flour.		
						Volume of loaf.	Texture of flour.				
Crop of 1912:		*P. ct.*	*P. ct.*	*Score.*	*P. ct.*	*C. c.*	*Score.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1424	Chouteau	75.3	2.4	92	59.4	1,920	88	11.00	10.16	12.43	10.8
1421	Cascade	74.0	2.47	94	61.8	2,020	90	12.77	10.73	13.85	12.2
1423	do	68.4	3.55	92	59.7	1,960	98	10.83	10.89	12.08	12.5
1487	do	72.7	1.89	96	57.9	2,220	94	11.00	9.61	12.08	12.6
1490	do	72.5	1.62	92	61.2	1,885	92	10.20	10.46	10.72	12.0
1572	do	72.4	2.63	94	57.9	2,130	92	12.60	10.60	13.34	13.1
1425	Fergus	72.3	3.35	93	59.7	1,970	92	11.23	10.01	12.43	12.0
1426	do	70.8	3.55	90	55.9	2,020	92	12.20	10.95	13.00	13.0
1427	do	75.2	4.05	90	57.9	1,940	85	12.83	9.97	13.51	10.9
1430	do	75.6	1.23	90	57.4	1,940	88	12.83	10.45	12.94	11.2
1431	do	73.7	1.84	92	59.1	1,945	88	12.20	10.90	13.85	11.5
1482	do	68.3	4.97	94	58.5	2,080	94	10.03	11.19	10.77	12.4
1483	do	71.9	[a] 1.12	90	57.9	2,265	94	12.08	10.24	12.77	13.0
1484	do	74.7	[a] .11	93	50.6	2,000	94	10.55	10.45	11.17	13.3
1525	do	71.6	4.48	92	57.4	2,160	93	10.55	11.08	11.63	14.8
1526	do	72.4	2.12	92	57.9	2,050	90	11.34	10.92	12.48	12.4
1559	do	74.4	2.93	98	56.2	2,005	93	10.26	10.74	11.17	14.0
1455	Gallatin	76.6	.24	90	54.4	1,860	90	11.63	10.61	11.51	12.7
1456	do	74.7	.52	94	53.8	1,905	90	9.80	10.56	10.60	12.4
1459	do	76.8	[a] .14	94	53.5	1,825	90	10.09	11.45	10.83	12.6
1491	do	70.3	4.17	95	59.1	2,100	93	11.17	10.64	11.80	12.8
1462	Yellowstone	72.4	4.59	95	58.8	1,940	94	11.40	9.81	11.97	12.6
1485	do	68.3	4.65	95	57.9	2,110	92	12.77	10.48	13.57	12.2
1486	do	64.7	3.73	95	54.1	1,925	92	8.95	10.46	9.06	13.7
1454	Rosebud	74.5	1.54	95	53.8	2,220	95	12.14	11.29	13.74	13.0
1458	do	72.3	1.21	96	56.2	2,230	90	11.40	11.38	13.05	14.1
Average (1912).		72.5	2.40	93.2	57.2	2,063	91	11.30	10.62	12.16	12.6
Crop of 1912: [b]											
1974	Fergus	70.8	4.6	97	60.6	2,120	92	10.72	11.71	11.57	13.0
1975	do	72.7	1.8	94	60.6	2,280	91	12.77	11.38	14.54	13.1
Crop of 1913:											
1973	do	72.4	2.7	96	61.8	2,070	92.5	11.97	11.55	13.40	12.5

[a] Gain in milling. [b] Tested in 1913.

Typical loaves from the flour of the 1912 wheat crop are shown in figure 3. The Montana wheat of the 1912 crop showed certain characteristics that were peculiar to most of the northern-grown wheats

FIG. 3.—Loaves of bread from Turkey wheat grown in Cascade and Fergus Counties, Mont., crop of 1912: *a*, From Cascade County; *b*, *c*, *d*, *e*, and *f*, from Fergus County.

that year. The wheat was quite uniformly plump and gave a good yield of flour, which, however, was not of the best color, being for the most part quite creamy. Likewise, the wheat of this year was not

of high baking strength, though containing a fair amount of gluten. In strength, as indicated by loaf volume and texture, this wheat was decidedly the poorest of the three years. This characteristic was apparently due to certain climatic conditions that were general throughout the 1912 wheat-growing season, as the same variations were noted with Montana spring wheat and the spring wheat of Minnesota and the Dakotas. This is shown diagrammatically in figure 4, which compares the loaf volume and texture of loaves made from flour representing wheats of the crops of 1911 and 1912. The results for northern spring wheat are based upon the average of tests with composite samples of spring wheat secured at Minneapolis and Chicago. Figure 5 is a diagrammatic presentation of the results of the milling and baking tests of the samples of the three years 1910, 1911, and 1912 and summarizes the results presented in Table II for those years.

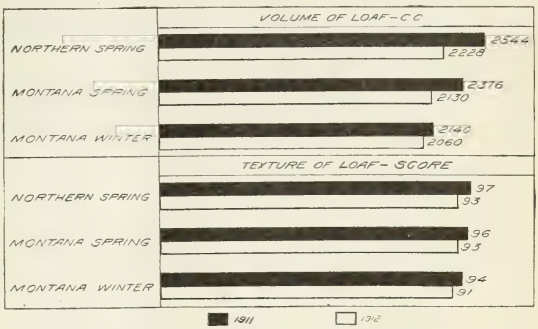


FIG. 4.—Diagram comparing northern-grown wheat of the 1911 and 1912 crops, showing the generally lower strength of the wheat crop of 1912.

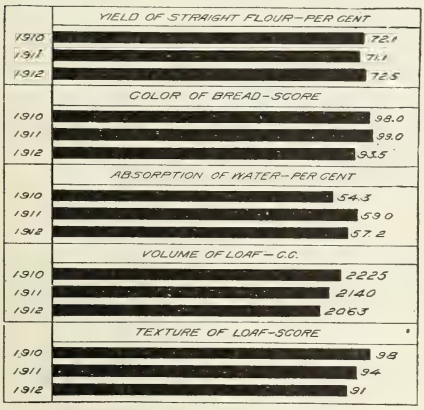


FIG. 5.—Diagram comparing the crops of 1910, 1911, and 1912 of Montana Turkey wheat.

CORRELATION OF PHYSICAL CHARACTERS AND MILLING QUALITY.

In order to determine how far the physical characteristics and condition of these samples could be correlated with actual quality, as evidenced by the milling and baking tests, several groupings were arranged in Table III. The arrangement of the samples in these tables was based upon notes taken after careful examination of the external appearance of each sample and then dividing them into several groups, as follows:

(1) Montana hard winter (Turkey) wheat, plump or fairly plump and bright to slightly bleached. Samples answering to this description were arranged in group A of Table III.

(2) Montana hard winter (Turkey) wheat, plump to a little shrunken, bleached, and a small percentage sprouted (Table III, group B).

(3) Montana hard winter (Turkey) wheat, plump to fairly thin, badly bleached, and a small percentage sprouted (Table III, group C).

(4) Montana hard winter (Turkey) wheat, badly bleached, and sprouted or badly shrunken (Table III, group D).

An attempt is made in Plate II to illustrate these groupings by reproducing photographs of typical samples from each group.

Each of the samples was also submitted to two or more persons acquainted with commercial practices, who were asked to give their opinions as to the proper grading and classification of the samples. This grading and also notes on "Condition" appear in the table.

A study of Table III reveals a number of interesting facts. As might be expected, the plump and sound samples falling in group A were of a uniformly high weight per bushel, a marked decrease occurring between each group. The grading followed this arrangement only roughly. In group A none of the samples were graded lower than No. 2 hard winter, though in one instance sample No. 1049 was graded No. 1 western red. In the succeeding groups there is considerable disagreement in the grading but not in the classification.

That the samples which are plump and sound are of highest quality from the standpoint of milling yield is clearly shown by a comparison of these groups. The average percentage of flour obtained from the samples falling in group A was 73.2 per cent, and in the three groups following, 71.7, 70.7, and 67.2 per cent, respectively. In the matter of flour quality, and especially in the factor of strength, however, the reverse is true, there being a marked increase in volume of loaf where there was a decrease in flour yield. This is in confirmation of the general observation that high baking strength is not generally found in wheat of extreme plumpness.

TABLE III.—*Correlation of physical characters and milling quality of Montana hard winter (Turkey) wheat for stated years.*

GROUP A.—GRAIN PLUMP OR FAIRLY PLUMP, BRIGHT TO SLIGHTLY BLEACHED, AND OTHERWISE SOUND.

Sample No.	Weight per bushel, cleaned.	Moisture in wheat.	Condition.	Commercial classification and grade.			Yield of straight flour.	Tests of straight flour.			
				Inspector A.	Inspector B.	Inspector C.		Color of bread.	Absorption of water.	Strength.	
										Volume of loaf.	Texture of loaf.
Crop of 1910:	*Pounds.*	*Per ct.*					*Per ct.*	*Score.*	*Per ct.*	*C. c.*	*Score.*
723	62	11.2		No. 1 hard winter		No. 1 hard winter	70.9	99	53.2	2,540	100
726	65	10.8	Sound, fairly plump	do		do	73.4	99	52.6	1,900	96
730	65	10.5	Sound, plump	do		do	72.0	96	52.4	2,230	96
733	64	10.3	Sound, fairly plump	do		do	72.6	99	54.4	2,110	96
737	64.5	10.2	do			do	73.0	97	56.5	2,250	98
738	66	12.0	do			do	72.2	96	53.8	2,130	98
739	65.5	12.9	do			do	72.8	99	54.7	2,130	99
742	66	9.8	do			do	74.2	98	54.1	1,950	98
745	63	12.1	Slightly bleached, plump	No. 1 hard winter		do	71.9	99	54.7	2,380	99
747	63.5	11.0	Sound, fairly plump	do		do	72.8	97	56.5	2,150	97
749	63	10.2	do	do		do	74.4	98	56.5	2,100	.....
Average (1910)	64.3	11.0					72.8	98	54.5	2,170	98
Crop of 1911:											
947	62	11.5	Sound, plump	do	No. 1 hard winter	do	72.8	98	60.0	2,100	94
1048	61	11.1	Sound, fairly plump	do	do	do	73.6	98	57.9	1,890	94
1049	61	11.2	do	do	No. 1 western red	No. 2 hard winter	74.0	98	56.5	2,140	94
1053	61	14.0	Sound, plump	do	No. 1 hard winter	No. 1 hard winter	70.3	98	58.2	2,100	93
1054	61	11.9	do	do	do	do	74.4	100	58.5	2,080	96
1058	60	14.0	Sound, fairly plump	do	No. 2 hard winter	No. 2 hard winter	72.1	98	58.5	2,040	93
1069	64	13.9	Sound, plump	do	No. 1 hard winter	No. 1 hard winter	74.6	94	58.2	1,880	92
1075	61.5	12.6	do	do	No. 2 hard winter	do	73.6	101	58.2	2,190	96
1110	61	14.6	do	do	do	No. 2 hard winter	71.9	98	58.8	2,070	94
1113	62	12.0	do	do	No. 1 hard winter	No. 1 hard winter	74.2	102	60.6	2,040	94
1118	61	11.5	do	do	No. 2 hard winter	do	73.4	97	57.9	2,020	94
Average (1911)	61.4	12.6					73.2	98	58.5	2,050	94
Crop of 1912:											
1421	61.5	12.2	Slightly bleached, fairly plump	do		No. 1 hard winter	74.0	94	61.8	2,020	90
1424	60	10.8	Sound, plump	do		do	75.3	92	59.4	1,920	88
1427	61	10.9	do	do		do	75.2	90	57.9	1,940	85

TABLE III.—*Correlation of physical characters and milling quality of Montana hard winter (Turkey) wheat for stated years*—Continued.

GROUP A.—GRAIN PLUMP OR FAIRLY PLUMP, BRIGHT OR SLIGHTLY BLEACHED, AND OTHERWISE SOUND—Continued.

Sample No.	Weight per bushel, cleaned.	Moisture in wheat.	Condition.	Commercial classification and grade.			Yield of straight flour.	Tests of straight flour.			
				Inspector A.	Inspector B.	Inspector C.		Color of bread.	Absorption of water.	Strength.	
										Volume of loaf.	Texture of loaf.
Crop of 1912—Contd.	*Pounds.*	*Per ct.*					*Per ct.*	*Score.*	*Per ct.*	*C. c.*	*Score.*
1430	62	11.2	Slightly bleached, fairly plump	No. 1 hard winter		No. 1 hard winter	75.6	90	57.4	1,940	88
1455	62.5	12.7	Slightly bleached, plump	do		do	76.6	90	54.4	1,860	90
1482	63	12.4	do	do		do	68.3	94	58.5	2,080	94
1490	65	12.0	Sound, plump	do		do	72.5	92	61.2	1,885	92
1526	64	12.4	Slightly bleached, plump	do		do	72.4	92	57.9	2,050	90
1559	61	14.0	Sound, plump	do		do	74.4	98	56.2	2,005	93
1572	62	13.1	Sound, shrunken	No. 2 hard winter		No. 2 hard winter	72.4	94	57.9	2,130	92
Average (1912)	62.2	12.2					73.7	93	58.3	1,983	90
3-year average	62.7	11.6					73.2	97	57.0	2,020	94

GROUP B.—GRAIN PLUMP TO A LITTLE SHRUNKEN, BLEACHED, AND A SMALL PERCENTAGE SPROUTED.

Crop of 1910:											
724	60	11.3	Bleached, shrunken	No. 2 hard winter		No. 2 hard winter	70.5	98	52.9	2,350	100
743	63	11.6	Bleached, sprouted, plump			do	72.1	98	53.2	2,300	98
748	61	11.3	Bleached, shrunken, sprouted	No. 2 hard winter		do	72.3	99	54.7	2,250	.....
750	61.5	12.0	do	do		do	70.8	96	56.2	2,150	.....
756	62	12.8	Bleached, plump	do		do	72.9	96	54.1	2,220	94
Average (1910)	61.5	11.8					71.7	97	54.2	2,254	97
Crop of 1911:											
1046	60.5	12.2	Bleached, 2 per cent sprouted, plump.	No. 1 hard winter	No. 3 hard winter	do	72.2	101	57.9	2,030	96
1056	64	10.2	Bleached, sprouted, plump	do	do	No. 3 hard winter	78.4	100	57.6	2,080	96
1062	61	11.8	Bleached, plump	No. 2 hard winter	do	No. 2 hard winter	72.2	101	57.9	2,190	96
1071	61	13.6	Bleached, 5 per cent sprouted, plump.	No. 1 hard winter	do	do	69.2	96	55.3	2,190	95
1076	60	13.0	Bleached, plump	No. 2 hard winter	do	do	69.4	99	57.6	2,170	95
1109	60	14.2	do	No. 1 hard winter	No. 2 hard winter	do	70.2	98	61.8	2,000	92

1114	61	14.7	....do	No. 3 hard winter	No. 3 hard winter		67.9	105	59.1	2,160	94
1115	60	13.0	Bleached, fairly plump	No. 2 hard winter	No. 2 hard winter	No. 2 hard winter	71.2	99	58.8	2,150	95
1119	59	11.4	Bleached, shrunken	....do	....do	....do	73.2	100	58.5	2,130	94
Average (1911)	60.7	12.7					71.5	100	58.3	2,122	95
Crop of 1912:											
1426	60	13.0	Bleached, sprouted, plump	No. 1 hard winter		No. 3 hard winter	70.8	90	55.9	2,020	92
1456	61	12.4	Bleached, plump	....do		No. 2 hard winter	74.7	94	53.8	1,905	90
1459	62	12.6	....do	No. 2 hard winter		....do	76.8	94	53.5	1,825	90
1462	60	12.6	....do			....do	72.4	95	58.8	1,940	94
1474	63	13.3	Bleached, sprouted, plump	No. 2 hard winter		....do	74.7	93	50.6	2,000	94
1485	62	12.2	Slightly bleached, shrunken	....do		....do	68.3	95	57.9	2,110	92
1486	62	13.7	Bleached, shrunken	....do		....do	64.7	95	54.1	1,925	92
1487	64	12.6	Bleached, plump	....do		....do	72.7	96	57.9	2,220	94
1525	62.5	14.8	Bleached, sprouted, plump	No. 1 hard winter		....do	71.6	92	57.4	2,160	93
Average (1912)	61.8	12.9					71.7	94	55.5	2,012	92
3-year average	61.3	12.1					71.7	97	56.3	2,108	94

GROUP C.—GRAIN PLUMP TO FAIRLY THIN, BADLY BLEACHED, AND A SMALL PERCENTAGE SPROUTED.

Crop of 1910:											
734	62	11.9	Badly bleached, sprouted, plump	No. 2 hard winter		No. 2 hard winter	72.0	98	52.4	2,280	96
Crop of 1911:											
1050	59	14.3	Badly bleached, 8 per cent sprouted, plump.	....do	No. 3 hard winter	No. 3 hard winter	70.9	98	59.7	2,340	94
1051	58	13.6	Badly bleached, 9 per cent sprouted, fairly plump.	No. 3 hard winter	....do	....do	68.6	97	58.2	2,230	96
1052	59	17.2	Badly bleached, 8 per cent sprouted, plump.	No. 2 hard winter	....do	....do	64.4	101	58.2	2,380	97
1108	60	13.6	Badly bleached, plump	No. 3 hard winter	....do	....do	69.0	101	59.7	2,250	94
1111	61	14.4	....do	No. 2 hard winter	....do	....do	70.2	103	61.5	2,130	94
1116	61	14.0	....do	....do	....do	....do	71.2	99	61.2	2,270	95
Average (1911)	59.7	14.5					69.1	100	59.8	2,267	95
Crop of 1912:											
1423	57.5	12.5	Bleached, shrunken	No. 1 hard winter		No. 3 hard winter	68.4	92	59.7	1,960	88
1425	58	12.0	Badly bleached, sprouted, plump	....do		....do	72.3	93	59.7	1,970	92
1431	57	11.5	....do	....do		....do	73.7	92	59.1	1,945	88
1454	60	13.0	....do	No. 2 hard winter		No. 2 hard winter	74.5	95	53.8	2,220	95
1458	59	14.1	....do	....do		No. 3 hard winter	72.3	96	56.2	2,230	90
1483	61	13.1	Badly bleached, shrunken	....do		No. 2 hard winter	71.9	90	57.9	2,265	94
1491	62	12.8	Badly bleached, sprouted, plump	....do		....do	70.3	95	59.1	2,100	93
Average (1912)	59.2	12.7					71.9	93	57.9	2,099	91
3-year average	59.6	13.4					70.7	96	58.3	2,191	93

TABLE III.—*Correlation of physical characters and milling quality of Montana hard winter (Turkey) wheat for stated years*—Continued.

GROUP D.—GRAIN BADLY SPROUTED OR BADLY SHRUNKEN.

Sample No.	Weight per bushel, cleaned.	Moisture in wheat.	Condition.	Commercial classification and grade.			Yield of straight flour.	Tests of straight flour.			
				Inspector A.	Inspector B.	Inspector C.		Color of bread.	Absorption of water.	Strength.	
										Volume of loaf.	Texture of loaf.
Crop of 1911:	*Pounds.*	*Per ct.*					*Per ct.*	*Score.*	*Per ct.*	*C.c.*	*Score.*
1066	55	13.4	Shrunken, 30 per cent sprouted	No. 3 hard winter	No. 4 western red	No. 4 hard winter	66.9	94	56.8	2,190	90
1078	56	13.4	Shrunken, 6 per cent sprouted	No. 4 hard winter	do	do	68.3	95	55.0	2,100	96
1117	58	12.0	Shrunken	No. 3 hard winter	No. 3 hard winter	No. 3 hard winter	66.5	94	60.2	2,370	95
Average (1911)	56.3	12.9					67.2	94.3	57.3	2,220	93.6

COMPARISONS WITH THE HARD WINTER WHEATS OF OTHER SECTIONS.

How does the quality of Montana-grown hard winter wheat compare with that grown in other sections? Outwardly the kernels appear to be a little larger, more uniform, and somewhat more plump on the average. The kernels are very hard and vary in color from dark amber to reddish. The "yellow berry," so prevalent in some sections, is not common in Montana, although it has occasionally been observed. That there is almost as great a variation in the characteristics and quality of the wheat of this State as in all other sections of the United States where hard winter wheat is grown is shown in figures 6 to 13.

In milling quality, restricting the meaning of this term to flour yield, the Montana-grown wheat resembles the hard winter wheats of the central Plains area very closely. This is evidenced by a comparison of the data shown diagrammatically in figures 6, 7, and 8. The flour yield does not appear to average quite as high in the comparisons made in figure 6, but this is readily explained by the fact that on the average the Montana samples were considerably higher in moisture content, a factor which very materially influences the flour yield, as is clearly illustrated in figure 7. In flour color the Montana wheat shows up to advantage, as none of the samples tested were seriously injured by the presence of smut or from field damage, as was the case with a number of samples from other sections.

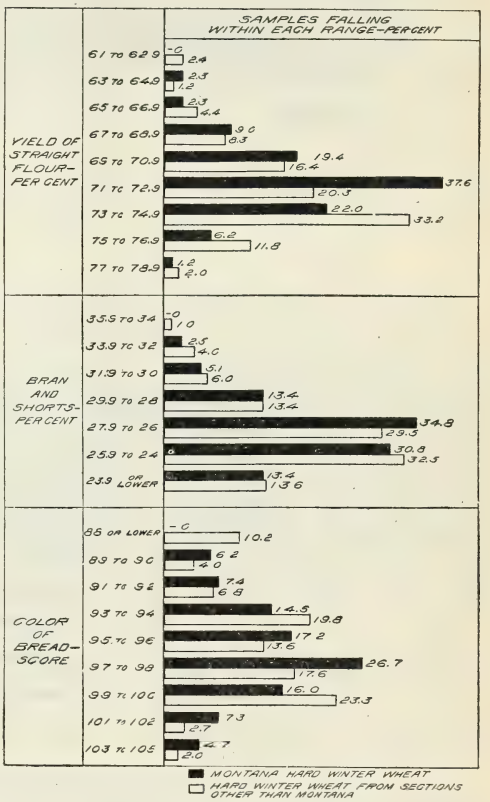


FIG. 6.—Diagram comparing the milling quality (yield of straight flour, bran, and shorts, and color of flour) of Montana hard winter wheat with that of the hard winter wheat of other sections. The results of tests of samples of the crops of 1908 to 1913, inclusive, are shown.

Figure 8 shows that in weight per measured bushel the Montana wheat has about the same range as that observed in the wheat from

other hard winter-wheat sections, a very large percentage of the samples falling between 60 and 64 pounds in both instances. The general relationship between weight per bushel and flour yield is also illustrated in this diagram. With increase in weight per bushel it will be noted that there is also an increase in the average flour yield.

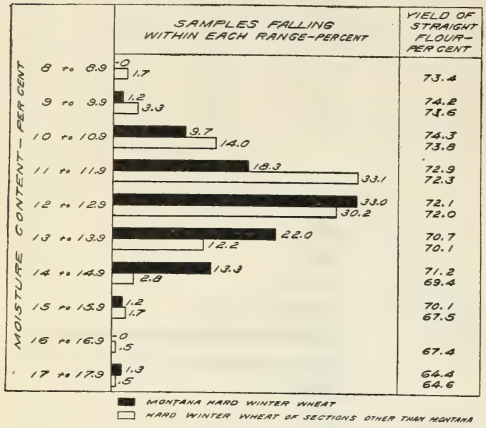


FIG. 7.—Diagram comparing the moisture content of Montana hard winter wheat with the hard winter wheat of other sections and showing the relationship of this factor to the average flour yield.

As is illustrated in figure 9, the baking strength of Montana hard winter-wheat flour is lower on the average than that of other sections, when the factors of loaf volume and texture are considered. This difference is undoubtedly emphasized by the unusually low strength of the Montana wheat in 1912, but, on the other hand, very few of the Montana samples showed the very high strength of the "shoepeg" or dark Turkey wheat of central and western Kansas. Figure 10 illustrates this point. The loaf marked *a* is made from a hard dark Turkey wheat from Kansas and is decidedly superior in strength to any of the other samples shown. On

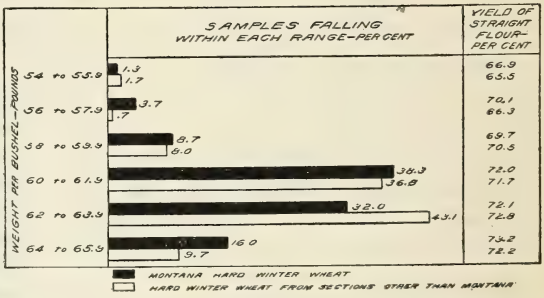


FIG. 8.—Diagram comparing the weight per bushel of Montana hard winter wheat with that of the hard winter wheat of other sections, showing the relationship of this factor to the average flour yield.

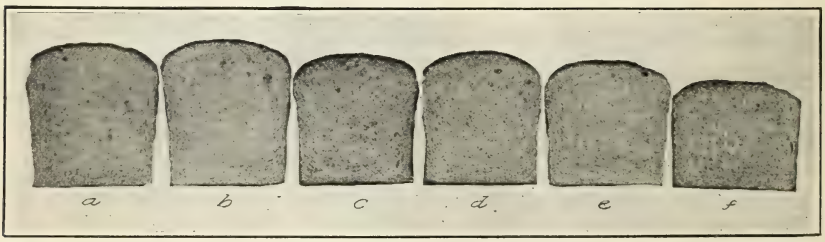


FIG. 9.—Comparison of loaves from Montana-grown wheat with a composite sample of No. 2 hard winter wheat from Chicago, Ill., crop of 1912: *a*, Chicago No. 2 hard winter; *b*, Turkey, from Rosebud County, Mont.; *c*, *d*, and *e*, Turkey, from Gallatin County, Mont.; *f*, Spring Club (western white), from Gallatin County.

the other hand, the loaf marked *b* represents "yellow" Turkey

FIG. 10.—Comparison of loaves from No. 2 hard winter wheat obtained at Kansas City, Mo., with samples of Montana Turkey wheat, crop of 1911: *a*, No. 2 hard winter (dark), Kansas City; *b*, No. 2 hard winter (yellow), Kansas City; *c*, *d*, and *e*, Montana-grown Turkey. Part of the apparent difference in color is due to unequal lighting. Notice the similarity of *b* to *c*, *d*, and *e* and the superiority of *a* in baking strength.

wheat from Kansas and resembles very closely loaves *c*, *d*, and *e*, which are from Montana Turkey wheat. The conclusion that may be drawn from this illustration is that although Montana wheat does not often exhibit exceptionally high strength, yet practically all samples fall within the general range in quality found in the hard winter wheat of other sections. That this condition might be reversed in

FIG. 11.—Cross section of loaves baked from the flour of Montana-grown hard winter wheat and St. Louis No. 2 hard winter: *a*, St. Louis No. 2 hard winter; *b*, No. 2 hard winter wheat, from the port of New York, said to be Montana wheat; *c*, Turkey, from Fergus County, Mont. All loaves are similar; *a*, however, has the best texture.

FIG. 12.—Comparison of bread from Montana wheat with a sample of No. 2 hard winter from Chicago: *a*, Chicago No. 2 hard winter; *b*, Turkey, from Yellowstone County; *c*, *d*, and *e*, Turkey, from Gallatin County; *f*, Spring Club (white), from Gallatin County.

some seasons is within the range of possibility. The point is that local climatic and other environmental factors have great influence on the

quality of the wheat and these factors may vary greatly from year to year. The usual differences that are found in bread made from hard winter-wheat flour are well illustrated in figures 11 and 12, and it will be noted that as a rule the loaves from the Montana wheat do not suffer by comparison.

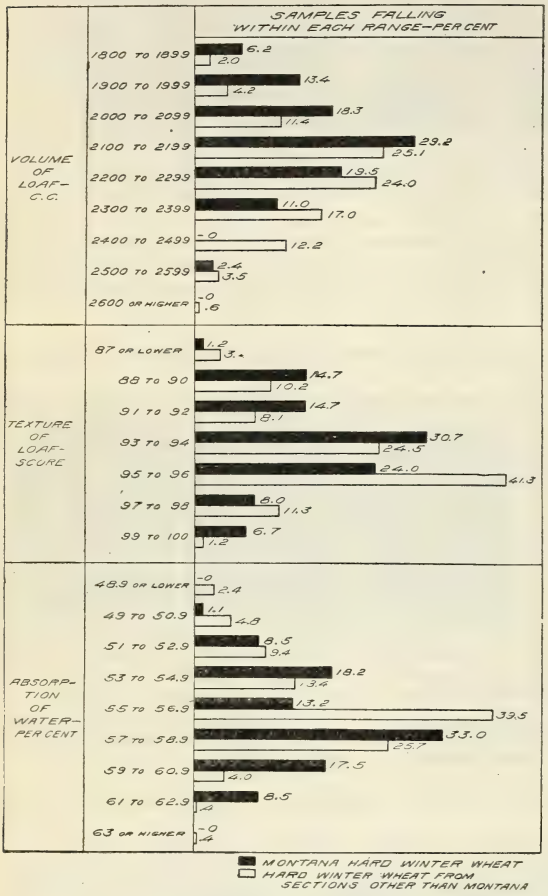


FIG. 13.—Diagram comparing the strength (loaf volume, texture, and water absorption) of the flour from Montana hard winter wheat with that from hard winter wheat of other sections. The results of tests of samples of the crops of 1908 to 1913, inclusive, are shown.

One factor which has not yet been mentioned is water absorption of the flour. The comparisons made diagrammatically in figure 13 show that the Montana wheat flour shows up rather more favorably than the general run of flour from hard winter wheat of other sections.

To summarize these comparisons between Montana hard winter wheat and that of other sections, it may be said that, eliminating the differences brought about by high moisture content, the Montana wheat, which is plump and sound and of high weight per bushel, gives about the same flour yield as similar hard winter wheat from other sections and that the color of the flour is likewise equal, if not better. In baking quality few, if any, of the Montana samples showed exceptionally high strength, but all of them fell within the range of quality found in the hard winter wheat of other sections, although with a lower general average. The flour from the Montana wheat averages considerably higher in water absorption.

MONTANA HARD SPRING WHEAT.

Montana-grown spring wheat of the common varieties of the Fife and Bluestem groups when received at primary markets is as a rule classified and graded on the same basis as the hard spring wheat grown in the Dakotas and Minnesota; that is, as northern spring wheat. Spring wheat, like the winter wheat grown within the State of Montana, has a somewhat larger and plumper kernel, but in milling quality and general characteristics it does not seem to differ materially from the general run of the spring wheat of the Dakotas and Minnesota, except that the tendency toward lower baking strength as a corollary to the plumper kernels seems to exist here also.

The same variations in baking strength of the crops of 1910, 1911, and 1912 are apparent with the spring wheats as were observed with the winter wheats. Drawing conclusions from Tables IV, V, and VI, it appears that the spring wheat of the crops of 1908 to 1910, inclusive, was of a quality much superior to that of the two succeeding years, and that the wheat of the 1912 crop, like that of the northern-grown wheat, was generally low in strength, as shown in figure 4. Complete information in regard to the spring-wheat samples is to be found in Tables IV and V.

Table V shows some of the characteristics and quality of each sample and the relationship of these factors to their commercial rating and milling quality. It will be noted that the dry, sound, and plump samples are usually high in milling quality, though no very great range is observed. The classification and grading of these samples were quite uniform. The grade appraised is more nearly dependent upon the external appearance of the samples than upon other factors as would be expected, bleached, sprouted, and "frosted" samples being the only ones grading lower than No. 1 northern. The tendency of throwing into the western red class samples which are not up to the standard is noted in connection with sample No. 1057.

TABLE IV.—*Baking tests of Montana spring wheat, showing sources of samples, variety, and milling quality for five successive years.*

Sample No.	County in which grown.	Variety.	Tests of straight flour.								Crude protein in wheat, N×5.7.	Moisture in wheat.
			Yields of straight flour.	Loss in milling.	Color of bread.	Absorption of water.	Strength.		Crude protein in flour, N×5.7.	Moisture in flour.		
							Volume of loaf.	Texture of loaf.				
			Per cent.	*Per cent.*	*Score.*	*Per cent.*	*C. c.*	*Score.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Crop of 1908:												
298 [a]	Cascade	Mixed [b]	71.5	0.72	100	56.2	2,490	.....	12.77	8.49	13.74	11.9
358 [a]	Fergus	65 per cent Fife.	73.2	[c] 1.68	102	56.5	2,305	.....	12.89	.....	13.34	11.2
Crop of 1909:												
506	Cascade	.....	72.1	[c] .2	100	51.8	2,450	.....	11.51	11.34	11.63	13.4
509	Gallatin	.....	63.4	2.0	103	51.5	2,530	.....	10.60	11.44	11.17	13.8
Crop of 1910:												
735	Cascade	Mixed [b]	70.2	.6	102	54.4	2,640	100	11.46	10.39	11.17	12.3
736	....do	...do [b]	71.4	2.4	99	53.2	2,600	98	13.34	10.26	14.59	11.7
740	Fergus	Fife	72.5	1.5	99	54.7	2,420	98	13.11	10.09	13.91	11.9
741	....do	...do	68.2	3.5	96	52.9	2,580	100	13.62	10.07	13.51	11.8
744	....do	...do	71.0	.3	100	51.8	2,400	100	11.97	10.82	12.48	13.2
727	Gallatin	...do	70.2	3.1	101	52.9	2,580	100	11.86	10.85	13.05	12.3
731	....do	...do	73.4	2.1	96	52.4	2,310	96	10.37	11.10	10.49	14.2
725	Yellowstone	...do [b]	72.4	1.7	102	53.2	2,500	100	12.71	10.17	13.74	11.6
Average (1910).	.....	.....	71.2	1.9	99	53.9	2,504	99	12.31	10.47	12.87	12.4
Crop of 1911:												
948	Cascade	Fife	69.4	1.8	103	58.8	2,515	98	10.37	10.86	11.12	14.0
1073	....do	Mixed [b]	72.5	.3	99	57.1	2,350	96	12.31	11.01	14.14	14.6
1074	....do	...do. [b]	69.8	3.4	100	58.5	2,570	100	12.25	10.90	12.37	14.9
1070	Flathead	Fife	70.2	2.2	98	61.8	2,300	95	11.34	9.99	11.57	13.6
1059	Meagher	...do	74.6	2.2	97	59.4	2,190	93	11.97	9.40	12.14	13.6
1057	Ravalli	...do	70.1	3.2	97	57.4	2,330	95	10.55	10.98	10.83	15.4
Average (1911).	.....	.....	71.1	2.2	99	58.8	2,376	96	11.46	10.52	12.03	14.4
Crop of 1912:												
1470	Valley	Bluestem	70.2	4.1	94	58.2	2,080	94	10.89	10.70	11.63	14.2
1429	Chouteau	Fife	70.4	4.0	93	58.5	2,090	90	12.20	10.29	12.54	13.6
1422	Cascade	...do	70.7	4.0	95	59.1	2,295	94	13.45	.....	14.19	12.3
1488	....do	Mixed [b]	70.9	4.3	94	58.3	2,110	92	12.14	9.67	12.60	12.4
1489	....do	...do. [b]	71.5	3.4	96	60.0	2,085	93	11.63	10.34	11.63	14.1
1533	....do	...do. [b]	73.5	.6	98	56.8	2,210	95	11.40	9.61	11.57	12.0
1428	Fergus	Bluestem	71.7	3.4	95	58.5	2,055	90	12.48	10.56	12.37	11.8
1457	Gallatin	Fife	75.2	1.4	92	56.2	2,060	94	11.97	11.33	12.60	14.8
1461	....do	...do	69.4	4.7	93	59.7	2,180	94	12.31	11.21	12.43	13.0
Average (1912).	.....	.....	71.5	3.3	94	58.4	2,129	93	12.05	10.46	12.40	13.1
5-year average.	.....	.....	71.1	2.3	98	56.4	2,342	96	11.98	10.47	12.47	13.1

[a] Baking test upon approximately a 70 per cent patent flour.
[b] Largely Fife and Bluestem.
[c] Gain in milling.

TABLE V.—*Correlation of physical characters and milling quality of Montana hard spring wheat, showing condition, commercial grading, and milling and baking quality of samples for three successive years.*

Sample No.	Weight per bushel, cleaned.	Moisture in wheat.	Condition.	Commercial classification and grade.			Yield of straight flour.	Tests of straight flour.			
				Inspector A.	Inspector B.	Inspector C.		Color of bread.	Absorption of water.	Strength.	
										Volume of loaf.	Texture of loaf.
Crop of 1910:	*Lbs.*	*Per ct.*					*Per ct.*	*Score.*	*Per ct.*	*C. c.*	*Score.*
725	62	11.6	Bleached, plump	No. 1 northern		No. 1 northern	72.4	102	53.2	2,500	100
727	61.	12.3	Bleached, 10 per cent white, plump	do		No. 2 northern	70.2	101	52.9	2,580	100
731	65	14.2	Sound, plump	do		No. 1 hard spring	73.4	96	52.4	2,310	96
735	61	12.3	Sound, fairly plump	do		No. 1 northern	70.2	102	54.4	2,640	100
736	60	11.7	Bleached, shrunken	No. 2 northern		do	71.4	99	53.2	2,600	98
740	62	11.9	Sound, fairly plump			do	72.5	99	54.7	2,420	98
741	61	11.8	do			do	68.2	96	52.9	2,580	100
744	63.5	13.2	Sound, plump	No. 1 northern		No. 1 hard spring	71.0	100	51.8	2,400	100
Average (1910)	61.9	12.4					71.2	99	53.9	2,504	99
Crop of 1911:											
948	62	14.0	Sound, plump	No. 1 northern	No. 2 northern	No. 1 northern	69.4	103	58.8	2,515	98
1057	60.5	15.4	Bleached, "frosted"	do	No. 4 western red	No. 3 northern	70.1	97	57.4	2,330	95
1059	61	13.6	Sound, plump	do	No. 1 northern	No. 1 northern	74.6	97	59.4	2,190	93
1070	61	13.6	Sound, fairly plump	do	No. 1 hard spring	do	70.2	98	61.8	2,300	95
1073	61	14.6	Bleached, plump	do	No. 1 northern	do	72.5	99	57.1	2,350	96
1074	59	14.9	do	No. 2 northern	No. 3 northern	No. 2 northern	69.8	100	58.5	2,570	98
Average (1911)	60.8	14.4					71.1	99	58.8	2,376	96
Crop of 1912:											
1422	58	12.3	Slightly bleached, shrunken	No. 1 northern		No. 1 northern	70.7	95	59.1	2,295	94
1428	61	11.8	Slightly bleached, fairly plump	do		do	71.1	95	58.5	2,055	90
1429	57	13.6	Sound, shrunken	do		do	70.4	93	58.5	2,090	90
1457	60.5	14.8	Sound, plump	No. 1 hard spring		No. 1 hard spring	75.2	92	56.2	2,060	94
1461	58	13.0	Bleached, plump, "frosted"	No. 2 northern		No. 3 northern	69.4	93	59.7	2,180	94
1470	59	14.2	Bleached, shrunken			No. 2 northern	70.2	94	58.2	2,080	94
1488	62	12.4	Slightly bleached, fairly plump	No. 1 northern		No. 1 northern	70.9	94	58.3	2,110	92
1489	60.5	14.1	Bleached, sprouted, fairly plump	No. 2 northern		No. 2 northern	71.5	96	60.0	2,085	93
1533	61	12.0	Slightly bleached, plump	No. 1 hard spring		No. 1 hard spring	73.5	98	56.8	2,210	95
Average (1912)	59.7	13.1					71.5	94	58.4	2,129	93
3-year average	60.7	13.2					71.3	97	56.9	2,324	96

In Table VI and figure 14 a comparison is made of the average baking values of Montana spring wheats of the 1911 and 1912 crops with average commercial Nos. 1, 2, and 3 northern wheat. The commercial samples were secured at large terminal markets and represent in each case the average of 20 to 30 car lots for each of the grades. From the figures given here, the conclusion may be drawn that the

FIG. 14.—Comparison of bread from three grades of Minneapolis spring wheat with that of Montana-grown wheat, crop of 1912: *a*, *b*, and *c*, Nos. 1, 2, and 3 northern, Minneapolis; *d*, Fife (hard spring), Gallatin County; *e*, Fife, said to be hard winter, Gallatin County; *f*, Bluestem (hard spring), Valley County.

Montana wheat about equals average spring wheat in quality, except that as a rule the flour will not be found to rank as high in baking strength. What has been said of the winter wheat relative to strength applies equally well to the spring wheat, for, although the average is somewhat lower, about the same range in quality is observed in the spring wheat of other sections as is found in that grown in Montana.

TABLE VI.—*Baking tests of Montana hard spring wheats compared with average commercial Nos. 1, 2, and 3 northern, crops of 1911 and 1912.*

Class or type.	Number of samples.	Yield of straight flour.	Tests of straight flour.						Crude protein in wheat, N×5.7.	Moisture in wheat.
			Color of bread.	Absorption of water.	Strength.		Crude protein in flour, N×5.7.	Moisture in flour.		
					Volume of loaf.	Texture of loaf.				
Crop of 1911:		*Per ct.*	*Score.*	*Per ct.*	*C.c.*	*Score.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Montana hard red spring	6	71.1	99	58.8	2,376	96	11.46	10.52	12.03	14.4
Average commercial spring wheat—										
No. 1 northern	17	71.9	99	56.9	2,517	97	12.22	10.67	13.11	12.5
No. 2 northern	15	70.4	99	57.0	2,561	97	12.18	10.41	13.17	13.0
No. 3 northern	10	68.6	98	56.7	2,631	97	12.47	10.68	12.98	13.1
Crop of 1912:										
Montana hard red spring	9	71.5	94	58.4	2,129	93	12.05	10.46	12.40	13.1
Average commercial spring wheat—										
No. 1 northern	5	72.6	93	56.3	2,228	94	11.53	10.75	11.97	13.1
No. 2 northern	5	71.3	92	56.4	2,246	93	11.69	10.99	12.34	13.1
No. 3 northern	5	71.9	91	56.7	2,210	93	11.70	10.56	12.52	12.8

Figure 15 shows a comparison of the bread from Montana-grown wheat and that from a composite sample of Minneapolis No. 1 northern, crop of 1912: *a*, No. 1 northern, Minneapolis; *b*, Fife, Gallatin

County; *c*, Turkey, Yellowstone County; *d*, Bluestem, Valley County; *e*, Fife, Gallatin County, described as hard winter wheat; *f*, durum, Valley County.

WESTERN RED AND WHITE WHEAT.

Under the head of western wheat is properly classified the wheat of the soft varieties, both red and white. Commercially these wheats are conveniently separated under two classes. The western red class includes a number of varieties, of which Crail Fife is principally grown, and is an especial favorite in irrigated districts because of its large yields under this treatment. In general properties, the flour produced therefrom resembles flour from soft red wheat. A number of other varieties are grown within the State. Of these, one called Velvet Chaff resembles the Crail Fife wheat very closely in milling and baking quality. Galgalos is a peculiar variety which mills much like a soft wheat, producing a characteristic light, fluffy flour, but, on the other

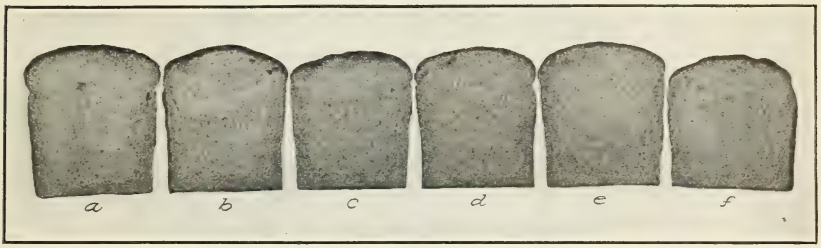


FIG. 15.—Comparison of bread from Montana-grown wheat with that from a composite sample of Minneapolis No. 1 northern wheat, crop of 1912: *a*, No. 1 northern, Minneapolis; *b*, Fife, Gallatin County, Mont.; *c*, Turkey, Yellowstone County; *d*, Bluestem, Valley County; *e*, Fife, Gallatin County, described as hard winter wheat; *f*, durum, Valley County.

hand, it is more glutinous and usually has better baking qualities. Crimean spring and Pringle Champlain are varieties which perhaps should be classified as hard spring wheat, but such results as so far have been secured indicate that they are inferior to the standard varieties, such as Fife and Bluestem. Complete milling and baking results with samples of these wheats are given in Table VII. Further information as to the condition of the individual samples and the commercial classification is given in Table VIII.

In Tables IX and X are presented similar results with Montana-grown white wheats. These varieties of white wheat are also largely grown upon irrigated lands and are of even a more starchy and softer character than the Crail Fife. Because of the light, fluffy nature of the flour it was very difficult to estimate accurately the quantity of flour that could be produced from this wheat with the milling machinery which was available. The yield figures should be considerably higher than those given in the tables. The flour of this wheat is very low in crude protein and in baking strength.

TABLE VII.—*Baking tests of Montana soft and semihard red wheats, showing sources of samples, variety, and milling quality for four successive years.*

Sample No.	County in which grown.	Variety.	Yield of straight flour.	Loss in milling.	Tests of straight flour.						Crude protein in wheat, N×5.7.	Moisture in wheat.
					Color of bread.	Absorption of water.	Strength.		Crude protein in flour, N×5.7.	Moisture in flour.		
							Volume of loaf.	Texture of loaf.				
Crop of 1908:			*Per cent.*	*Per cent.*	*Score.*	*Per cent.*	*C. c.*	*Score.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
295 [a]	Gallatin	Crail Fife	65.8	5.3	102	51.5	1,740	.....	8.78	7.73	9.92	11.5
356 [a]	Moore	do	72.9	2.5	102	52.4	1,900	.....	10.03	.....	9.98	9.7
Crop of 1909:												
510	Gallatin	do	67.3	4.4	94	50.3	1,970	.....	11.34	10.90	12.08	13.0
Crop of 1910:												
728	do	do	66.6	5.4	102	48.5	1,930	93	10.60	10.70	10.89	11.9
Crop of 1911:												
1065	Fergus	Galgalos	62.3	4.6	95	60.9	2,180	94	14.82	8.98	16.53	14.4
1077 [b]	do	Crimean, spring	66.1	1.9	96	59.1	2,230	90	13.40	10.04	13.91	13.4
1072	Flathead	Velvet chaff, winter	68.6	6.5	99	58.2	1,780	85	9.86	10.19	9.98	13.8
1045	Gallatin	Pringle Champlain	80.0	0	94	57.6	2,010	89	11.34	9.41	11.97	12.6
1145	do	Crail Fife	70.4	[d] 1.6	96	53.5	1,460	80	10.83	11.00	11.97	11.9
1060 [b]	Broadwater	Pringle Champlain	73.3	1.7	92	60.3	2,180	94	15.16	8.80	15.96	11.2
1068 [b]	Park	do	70.8	2.9	94	57.9	1,890	90	10.77	9.90	10.55	13.6
912 [c]	.....	Mixed	70.2	2.2	96	53.8	1,650	82	8.61	10.52	9.18	12.8
913 [c]	.....	do	72.3	1.1	95	52.9	1,470	70	8.55	10.39	9.18	11.6
3-year average	.....	.....	68.5	3.4	98	53.6	1,787	84	10.38	10.05	11.08	12.3

[a] Baking tests with approximately a 70 per cent patent flour.
[b] Crimean spring and Pringle Champlain of doubtful classification. The average is exclusive of these samples.
[c] Sample 912, No. 1 western red, Minneapolis; 913, No. 1 western red, Duluth.
[d] Gain in milling.

TABLE VIII.—*Correlation of physical characters and milling quality of Montana soft and semihard wheats, showing the character, condition, and commercial classification of samples, crops of 1910 and 1911.*

Sample No.	Weight per bushel, cleaned.	Moisture in wheat.	Condition.	Commercial classification and grade.			Yield of straight flour.	Tests of straight flour.			
				Inspector A.	Inspector B.	Inspector C.		Color of bread.	Absorption of water.	Strength.	
										Volume of loaf.	Texture of loaf.
Crop of 1910:	*Pounds.*	*Per ct.*					*Per ct.*	*Score.*	*Per ct.*	*C. c.*	*Score.*
728	61	11.9	Badly bleached, plump	No. 2 western red		No. 2 western red	66.6	102	48.5	1,930	93
Crop of 1911:											
1065	60	14.4	Bleached, plump	No. 1 western red	No. 3 durum	do	62.3	95	60.9	2,180	94
1077 [a]	57.5	13.4	Bleached, shrunken	No. 3 western red	No. 4 hard winter	No. 4 western red	66.1	96	59.1	2,230	90
1072	61	13.8	Bleached, plump	No. 1 western red	No. 3 western red	No. 3 western red	68.6	99	58.2	1,780	85
1045 [a]	61	12.6	Sound, plump	No. 1 northern	No. 1 western red	No. 1 northern	80.0	94	57.6	2,010	89
1145	62	11.9	do	No. 3 western red		No. 4 western red	70.4	96	53.5	1,460	80
1060 [a]	56	11.2	Sound, shrunken	No. 3 northern	No. 2 northern	No. 3 northern	73.3	92	60.3	2,180	94
1068 [a]	60	13.6	Sound, plump	No. 1 northern	No. 1 northern	No. 1 northern	70.8	94	57.9	1,890	90
912 [b]	63	12.8					70.2	96	53.8	1,650	82
913 [c]	63	11.6					72.3	95	52.9	1,470	70
2-year average	61.7	12.7					68.4	97	54.6	1,745	84

[a] Crimean spring and Pringle Champlain of doubtful classification. Average exclusive of these samples.
[b] 912 sample of No. 1 western red, Minneapolis, Minn
[c] 913 sample of No. 1 western red, Duluth, Minn.

TABLE IX.—*Baking tests of Montana white wheat, showing sources of samples, variety, and milling quality for five successive years.*

Sample No.	County in which grown.	Variety.	Yield of straight flour.	Loss in milling.	Tests of straight flour.						Crude protein in wheat, N×5.7.	Moisture in wheat.
					Color of bread.	Absorption of water.	Strength.		Crude protein in flour, N×5.7.	Moisture in flour.		
							Volume of loaf.	Texture of loaf.				
Crop of 1908:			*Per cent.*	*Per cent.*	*Score.*	*Per cent.*	*C. c.*	*Score.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
296[a]	Gallatin	Fall Club	61.1	10.3	99	52.4	1,900	.....	7.92	8.39	8.72	11.1
355[a]	Fergus	do	68.8	5.8	99	50.9	2,080	.....	10.55	.....	14.99	9.9
Crop of 1909:												
511	Gallatin	do	65.1	4.6	103	49.4	2,100	.....	7.35	11.53	9.23	13.5
Crop of 1910:												
729	do	Spring Club	67.2	5.6	98	47.6	1,660	93	8.72	9.51	8.78	11.2
732	do	do	68.3	2.9	97	47.1	1,610	93	7.52	11.16	8.61	11.6
746	Fergus	Sonora	66.4	7.3	96	47.9	1,730	90	11.34	9.94	11.34	12.5
Crop of 1911:												
1047	Gallatin	Stanley spring	64.2	10.3	94	55.0	1,550	80	10.83	8.93	10.77	13.6
1055	Ravalli	Spring Club	66.8	6.4	90	53.2	1,695	86	9.12	9.52	9.86	14.2
1144	Gallatin	Club	71.2	2.9	96	52.6	1,800	88	9.41	10.89	9.98	11.6
911A[b]	.....	.....	70.1	2.4	94	52.9	1,760	82	10.20	9.59	10.60	11.8
Crop of 1912:												
1460	Gallatin	Fall Club	64.8	6.1	92	50.9	1,435	70	7.64	11.29	7.58	13.5
5-year average	.....	.....	66.7	5.9	96	50.9	1,756	85	9.16	9.98	10.12	12.2

[a] Baking tests with approximately a 70 per cent patent flour.

[b] No. 1 western white wheat secured at Minneapolis, Minn.

TABLE X.—*Correlation of physical characters and milling quality of Montana white wheat, showing condition and commercial grading of samples for three successive years.*

Sample No.	Weight per bushel cleaned.	Moisture in wheat.	Condition.	Commercial classification and grade.			Yield of straight flour.	Tests of straight flour.			
				Inspector A.	Inspector B.	Inspector C.		Color of bread.	Absorption of water.	Strength.	
										Volume of loaf.	Texture of loaf.
Crop of 1910:	*Pounds.*	*Per ct.*					*Per ct.*	*Score.*	*Per ct.*	*C. c.*	*Score.*
729	61.5	11.2	Bleached, plump	No. 1 western white.		No. 2 western white.	67.2	98	47.6	1,660	93
732	62.5	11.6	Sound, plump	do		No. 1 western white.	68.3	97	47.1	1,610	93
746	63	12.5	Sound, shrunken	do		No. 2 western white.	66.4	96	47.9	1,730	90
Crop of 1911:											
1047	60	13.6	Bleached, "frosted"	No. 2 western white.	No. 4 western white.	No. 4 western white.	64.2	94	55	1,550	80
1055	61	14.2	Shrunken, sound	No. 1 western white.	No. 2 western white.		66.8	90	53.2	1,695	86
1144	59	11.6	Bleached, fairly plump, "frosted"	No. 3 western white.		No. 3 western white.	71.2	96	52.6	1,800	88
911A	62	11.8			No. 1 western white.		70.1	94	52.9	1,760	82
Crop of 1912:											
1460	59	13.5	Bleached, shrunken, "frosted"	No. 2 western white.		No. 3 western white.	64.8	92	50.9	1,435	70
3-year average.	60.9	12.5					67.4	95	50.9	1,655	85

Table XI presents the results of baking tests of Montana soft red and white wheats of average quality as compared with average No. 2 red winter wheats grown in 1911 and 1912.

TABLE XI.—*Baking tests of Montana soft red and white wheats of average quality compared with average No. 2 red winter wheats, crops of 1911 and 1912.*

Character and class or type of samples.	Number of samples.	Yield of straight flour.	Tests of straight flour.						Crude protein in wheat, N×5.7.	Moisture in wheat.
			Color of bread.	Absorption of water.	Strength.		Crude protein in flour, N×5.7.	Moisture in flour.		
					Volume of loaf.	Texture of loaf.				
		Per ct.	*Score.*	*Per ct.*	*C. c.*	*Score.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Soft red wheat (western red), 4-year average, 1908–1911	13	68.5	98	53.6	1,787	84	10.38	10.05	11.08	12.3
Soft white wheat (western white), 5-year average, 1908–1912	11	66.7	96	50.9	1,756	85	9.16	9.98	10.12	12.2
Average commercial, No. 2 red winter, 1911 crop	43	69.4	98	52.9	1,989	93	9.90	9.89	10.72	11.4
Average commercial, No. 2 red winter, 1912 crop	20	69.4	95	51.6	1,853	91	8.65	10.50	9.47	12.7

MONTANA DURUM WHEAT.

Montana-grown durum wheat does not differ widely in any essential characteristic from the durum wheat grown in other sections.[1] It is very hard and flinty, and in grinding it a high percentage of a creamy or yellow flour is produced. The baking quality of this flour is usually somewhat poorer than that of hard winter wheat. As a rule, it contains a high percentage of crude protein. But two exceptions are noted to this in the samples examined, and, of these, one, No. 1067, contained a little less than 11 per cent of crude protein, while the second, No. 1469, contained about 9.5 per cent. The results of tests and a description of such durum wheat samples as were examined are to be found in Tables XII and XIII. Figure 12 affords a comparison of the bread from Montana durum wheat with that of other classes of wheat. As has already been suggested, durum wheat is admirably suited for the production of coarse flours and semolina for use in the manufacture of macaroni and other edible pastes. It is not especially suited for the production of white bread flours except for blending with the flours of other wheats. The yellow color of durum wheat is highly prized by the macaroni manufacturers.

[1] Ladd, E. F., and Bailey, C. H. Wheat investigations. Milling, baking and chemical tests. N. Dak. Agr. Exp. Sta. Bul. 89, p. 13–80. 1910.

——— ——— Wheat investigations. Milling, baking, and chemical tests. N. Dak. Agr. Exp. Sta. Bul. 93, p. 203–253. 1911.

TABLE XII.—*Baking tests of Montana durum wheat, showing source of the samples, variety, and milling quality for stated years.*

Sample No.	County in which grown.	Variety.	Yield of straight flour.	Tests of straight flour.					Crude protein in flour, N×5.7.	Moisture in flour.	Crude protein in wheat, N×5.7.	Moisture in wheat.
				Loss in milling.	Color of bread.	Absorption of water.	Strength.					
							Volume of loaf.	Texture of loaf.				
Crop of 1908:			*Per cent.*	*Per cent.*	*Score.*	*Per cent.*	*C. c.*	*Score.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
357[a]	Fergus		72.3	[b] 4.5	94	58.6	2,180	.....	13.17	.....	13.56	11.2
Crop of 1911:												
957	Custer	Kubanka	78.1	[b] 1.1	90	54.4	2,020	92	13.01	9.29	13.74	11.8
1,061	Broadwater	do	78.2	[b] .3	88	56.5	1,970	92	15.90	8.82	16.25	11.4
1,063	do	Pelessier	77.7	[b] .9	88	63.5	1,950	92	16.00	8.97	16.19	10.4
1,064	Fergus	Kubanka	78.5	[b] .8	78	57.1	2,000	88	15.75	10.16	16.70	14.5
1,067	Park		76.6	2.4	85	56.8	1,650	85	11.13	10.46	10.89	13.0
Crop of 1912:												
1,469	Valley		71.6	4.5	94	55.9	1,765	90	10.09	10.96	9.52	13.8
3-year average			76.1	[b] 2.1	88	57.6	1,934	90	13.58	9.78	13.84	12.3

[a] Baking tests with patent flour.

[b] Gain in milling.

TABLE XIII.—*Correlation of physical characters and milling quality of Montana durum wheat, showing condition and commercial classification of samples for 1911 and 1912.*

Sample No.	Weight per bushel, cleaned.	Moisture in wheat.	Condition.	Commercial classification and grade.			Yield of straight flour.	Tests of straight flour.			
				Inspector A.	Inspector B.	Inspector C.		Color of bread.	Absorption of water.	Strength.	
										Volume of loaf.	Texture of loaf.
Crop of 1911:	*Pounds.*	*Per ct.*					*Per ct.*	*Score.*	*Per ct.*	*C. c.*	*Score.*
957	60	11.8	Sound, fairly plump	No. 1 durum	No. 1 durum		78.1	90	54.4	2,020	92
1061	60	11.4	do	do	No. 2 durum		78.2	88	56.5	1,970	92
1063	60	10.4	do	do	No. 1 durum		77.7	88	63.5	1,950	92
1064	61	14.5	do	do	do		78.5	78	57.1	2,000	88
1067	61.5	13.0	Bleached, "frosted," fairly plump	do	No. 2 durum		76.6	85	56.8	1,650	85
Average	60.5	12.2					77.8	86	57.6	1,918	90
Crop of 1912:											
1469	63.5	13.8	Sound, fairly plump	No. 1 durum		No. 1 durum	71.6	94	55.9	1,765	90

SUMMARY OF THE CHARACTERISTICS OF THE FIVE CLASSES OF MONTANA WHEAT.

Five distinct classes of wheat are produced in Montana, which may be conveniently designated as hard spring, hard winter, western red,

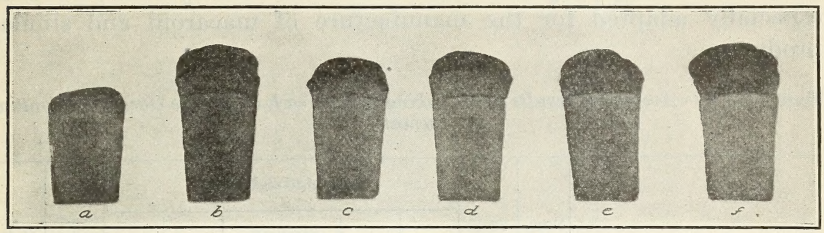


FIG. 16.—Comparison of the bread from three classes of Montana wheat, crop of 1911: *a*, Velvet Chaff (western red); *b*, Turkey, of unusual "strength," Fergus County; *c*, Fife, Meagher County; *d*, Fife, Flathead County; *e*, Cascade County, described as No. 1 northern; *f*, Cascade County, described as No. 2 northern.

western white, and durum. The two first-named classes are of about the same milling quality, except that the spring wheat is decidedly superior in baking strength. The wheats of these two classes also resemble each other closely in physical characteristics and composition; both are best suited for the production of a bread flour.

The flour from the western red and western white wheat is very low in strength and absorption and has the general characteristics of other soft-wheat flours. The flour is best adapted for the production of crackers and pastry products. The bread produced from this wheat is very close textured and heavy.

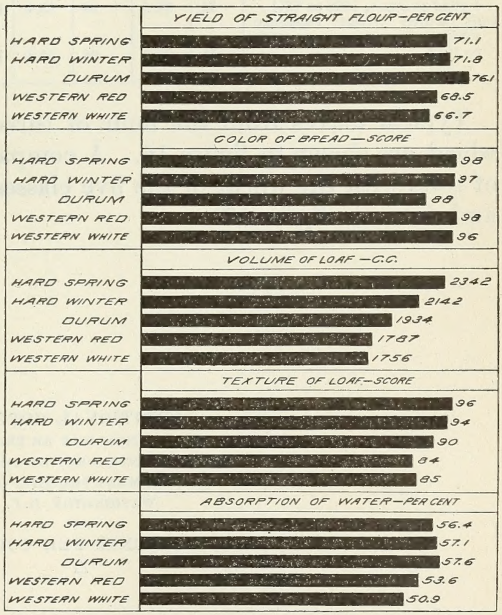


FIG. 17.—Diagram comparing the characteristics of the five groups of Montana-grown wheat.

Durum wheat is decidedly different from the wheat of any other class. Although generally yielding a high percentage of flour, the flour is usually very creamy or yellow in color and consequently receives a low score for color.

In spite of the fact that the flour contains a very high percentage of crude protein, it falls between the hard winter and western red wheats in baking strength. In water absorption the flour is slightly superior to that of all other classes. The flour from this wheat is not popular for bread-making purposes on account of its creamy color, but it is especially adapted for the manufacture of macaroni and similar products.

TABLE XIV.—*Average of results of all baking tests of each of the five classes of Montana wheat.*

Class or type.	Number of samples.	Yield of straight flour.	Tests of straight flour.						Crude protein in wheat, N×5.7.	Moisture in wheat.
			Color of bread.	Absorption of water.	Strength.		Crude protein in flour, N×5.7.	Moisture in flour.		
					Volume of loaf.	Texture of loaf.				
		P. ct.	*Score.*	*P. ct.*	*C. c.*	*Score.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Hard red spring, 5-year average, 1908 to 1912	27	71.1	98	56.4	2,342	96	11.98	10.47	12.47	13.1
Hard red winter, 5-year average, 1908 to 1912	79	71.8	97	57.1	2,142	94	11.73	9.89	12.20	12.4
Durum, 3-year average, 1908, 1911, and 1912	7	76.1	88	57.6	1,934	90	13.58	9.78	13.84	12.3
Soft red winter (western red), 4-year average, 1908 to 1911	13	68.5	98	53.6	1,787	84	10.38	10.05	11.08	12.3
Soft white wheat (western white), 5-year average, 1908 to 1912	11	66.7	96	50.9	1,756	85	9.16	9.98	10.12	12.2

Typical loaves from the flour of three classes of Montana-grown wheat are shown in figure 16. A comparison of the average results of tests with the wheat of the five classes is presented in Table XIV and shown in figure 17.

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